CLAIMS

1. A semiconductor device comprising:

a silicon substrate;

a gate electrode layer; and

a gate insulation film disposed between the silicon substrate and the gate electrode layer,

wherein

the gate insulation film is a high relative permittivity (high-k) film being formed by performing a nitriding treatment on a mixture of a metal and silicon.

2. The semiconductor device as claimed in claim 1, wherein the gate insulation film is formed according to a plasma CVD technology.

3. The semiconductor device as claimed in claim 1, wherein a silicon nitride film is formed as a barrier layer between the silicon substrate and the gate insulation film.

4. The semiconductor device as claimed in claim 3, wherein the silicon nitride film is formed according to a direct nitriding technology by plasma.

5. The semiconductor device as claimed in claim 1, wherein a silicon nitride film is disposed on the gate insulation film.

6. The semiconductor device as claimed in claim 5, wherein the silicon nitride film and the gate insulation film are alternately laminated on the silicon substrate.

7. The semiconductor device as claimed in claim 1, wherein a buffer layer is formed between the silicon substrate and the gate insulation film.

8. The semiconductor device as claimed in claime 1, wherein an alumina (Al_2O_3) monocrystal film is formed between the silicon substrate and the gate insulation film.

9. The semiconductor device as claimed in claim 8, wherein the alumina monocrystal film is formed according to a plasma CVD technology.

10. The semiconductor device as claimed in claim 1, wherein the gate insulation film has one of compositions selected from a following list:

$M_3Si_6N_{11}$ (M=La, Ce, Pr, Nd, Sm);

$M_2Si_5N_8$ (M=Ca, Sr, Ba, Eu);

$MYbSi_4M_7$ (M=Sr, Ba, Eu);

$BaSi_4N_7$;

$Ba_2Nd_7Si_{11}N_{23}$.

11. A method for manufacturing a semiconductor device comprising the steps of:

forming a gate insulation film which is a high relative permittivity (high-k) film by performing a nitriding treatment on a mixture of a metal and silicon; and

forming a gate electrode layer on the gate insulation film.

12. The method for manufacturing the semiconductor device as claimed in claim 11, wherein the gate

insulation film is formed according to a plasma CVD technology.

13. The method for manufacturing the semiconductor device as claimed in claim 11, further comprising the step of forming a silicon nitride film as a barrier layer between the silicon substrate and the gate insulation film.

14. The method for manufacturing the semiconductor device as claimed in claim 13, wherein the silicon nitride film is formed according to a direct nitriding by plasma.

15. The method for manufacturing the semiconductor device as claimed in claim 11, wherein a silicon nitride film is disposed on the gate insulation film.

16. The method for manufacturing the semiconductor device as claimed in claim 15, wherein the silicon nitride film and the gate insulation film are alternately laminated on the silicon substrate.

17. The method for manufacturing the semiconductor device as claimed in claim 11, further comprising the step of forming a buffer layer between the silicon substrate and the gate insulation film.

18. The method for manufacturing the semiconductor device as claimed in claim 11, further comprising the step of forming an alumina (Al_2O_3) monocrystal film between the silicon substrate and the gate insulation film.

19. The method for manufacturing the semiconductor device as claimed in claim 18, wherein the alumina monocrystal film is formed according to a plasma CVD technology.

20. The method for manufacturing the semiconductor device as claimed in claim 11, wherein the gate insulation film has one of compositions selected from a following list:

$M_3Si_6N_{11}$ (M=La, Ce, Pr, Nd, Sm);

$M_2Si_5N_8$ (M=Ca, Sr, Ba, Eu);

$MYbSi_4N_7$ (M=Sr, Ba, Eu);

$BaSi_4N_7$;

$Ba_2Nd_7Si_{11}N_{23}$.